ADVANCED AVIONICS ARCHITECTURE (A^3)

Engineering Directorate Technology Thrust Area

Marshall Space Flight Center (MSFC) • Huntsville, Alabama

Advanced Avionics Architecture (A^3) is a high emphasis technology activity of the Engineering Directorate. The A^3 thrust area was created to develop next generation avionics solutions for space transportation, space research, and scientific research. These solutions are developed to improve the safety, operability, flexibility, cognizance, and maintainability of space systems. Equipped with the proper technical skills and facilities, A^3 team members are developing avionics technology for both NASA and external customers.

STS-95 Space Shuttle and Spartan Satellite

VGS Flight Hardware

Technology Spotlight

Automated Rendezvous and Capture (AR&C)

The Automated Rendezvous and Capture (AR&C) system being developed under the A^3 thrust area will allow spacecraft to locate each other and rendezvous without human intervention. The International Space Station (ISS) and other spacecraft need this system to conduct routine dockings, resupply, and proximity operations missions. Currently, astronauts and ground crews manually guide the rendezvous spacecraft into position. AR&C will free astronauts from this repetitive task and thus allow more time for other activities such as space research. The operational version of the AR&C system is expected to function with a position accuracy of 3mm.

During the terminal phase of a rendezvous mission, the AR&C system is guided by the Video Guidance Sensor (VGS). This technology was developed by MSFC and successfully flight-tested in 1998 on the STS-95 Space Shuttle mission. Under orbital environmental conditions, the STS-95 flight experiment used the VGS to collect data while the Shuttle rendezvoused with the SPARTAN spacecraft. The VGS uses a combination of lasers, reflective devices, and a video detector to measure the relative position, attitude, and distance between spacecraft. MSFC has since developed and successfully marketed an Advanced Video Guidance Sensor, which will be used by Orbital Sciences and Boeing on other AR&C demonstrations for NASA and DARPA (Defense Advanced Research Projects Agency).

MSFC is planning a flight Demonstration of Autonomous Rendezvous Technology (DART) for April 2004 to begin establishing an operational AR&C capability for the United States. ISS integration and test activities will follow in 2006.

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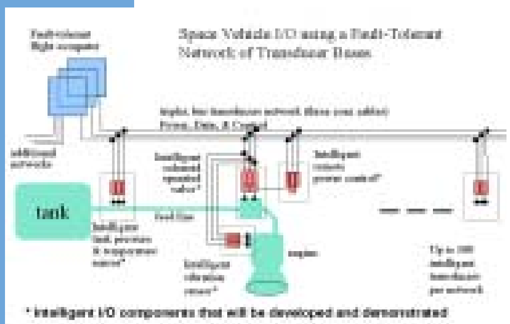
Additional A^3 Technologies

Scalable, Fault-Tolerant, Intelligent Network of Transducers (SFINX)



SFINX Architectural Concept

SFINX is a data and control architecture that offers to reduce cost, improve safety, and increase the flexibility of avionic systems on space vehicles. The A^3 system provides remote or autonomous reconfiguration to assure continuous and reliable system control. Even in the event of vehicle damage, the SFINX architecture allows access to redundant data busses of any number of physical sensors or controllers for assured availability of data and actuation commands. Not only do the busses carry multiple channels of information, but they also simultaneously provide power for the attached nodes. The effect is to significantly reduce the amount of wiring required, therefore reducing weight and increasing the reliability of the system as a whole. When fully developed, the SFINX architecture will yield a highly reliable, dependable, maintainable, adaptable and cost effective avionics system for the next generation of space systems.

Applications of Advanced Computing Technologies (AACT)

A^3 team members are configuring AACT that can be applied to NASA missions. For example, AACT is being developed for Soft Computing systems in Rocket Engine Control. This approach will improve safety and decrease cost of engine controllers and associated hardware test programs. AACT is also improving the safety and reliability of hardware by the development of Evolvable Control Hardware, which is inherently fault tolerant and can automatically be reconfigured in the event of failure.

Structural Health Monitoring

Advanced avionic sensors are being developed to monitor and control the state of health of vital structures on spacecrafts. These sensors and accutators will provide around the clock observation and modification of structures, which will improve the safety of missions by immediately alerting crewmembers of possible problems. Structural Health Monitoring systems may be created by embedding transducers in structural elements. Several universities and other NASA centers are collaborating with the A^3 team in this advanced technology.

Micro-Navigation Electronics

The application of the A^3 Micro-Navigation Electronics technology will reduce operation cost of space transportation systems. This technology uses MEMS (Micro-Electro-Mechanical Systems) devices. The lower energy consumption of micro-electric devices reduces the power demand and the thermal integration problem. Most importantly, however, Micro-Navigation Electronics provide robustness that translates into long lasting and low maintenance systems that easily reconfigure for different missions.

Micronavigator accelerometer